Earnings
Earnings for machine operators can vary based on a number of different factors. The most important are the size of the company, whether the shop is union or nonunion, the industry, and skill level and experience of the operator. Also, temporary employees, who are being hired in greater numbers, usually get paid less than company-employed workers. The median annual earnings in 1998 for a variety of metalworking and plastics-working operators were:

Lathe and turning machine setters and set-up operators	$28,250
Sheet metal workers and duct installers	28,030
Numerical control machine operators	27,110
Heat treating machine setters and operators	25,160
Metal molding machine setters and operators	24,870
Grinding machine operators	24,740
Machine tool cutting operators	24,510
Metal fabricators, structural metal products	24,070
Combination machine tool setters and operators	23,860
Punching machine setters and operators	23,270
Electrolytic plating machine setters and operators	21,210
Machine forming operators	20,170
Plastic molding machine setters and operators	18,580

Approximately one-third of these workers are union members, about double the rate for other workers in the economy. Metalworking industries have a higher rate of unionization than the plastics industry.

Related Occupations
Workers in occupations closely related to metalworking and plastics-working machine operators include machinists, tool and die makers, extruding and forming machine operators producing synthetic fibers, woodworking machine operators, and metal patternmakers. Numerical-control machine-tool operators may program CNC machines or alter existing programs, which are functions closely related to those performed by NC machine tool programmers.

Sources of Additional Information
For general information about the metalworking trades, contact:
☛ The National Tooling and Machining Association, 9300 Livingston Rd., Fort Washington, MD 20744. Internet: **http://www.ntma.org**
☛ The Precision Machined Products Association, 6700 West Snowville Rd., Brecksville, OH 44141. Internet: **http://www.pmpa.org**
☛ The Society of Plastics Industry, 1801 K St. NW, Suite 600K, Washington, DC 20006.
Internet: **http://www.socplas.org** and **http://www.certifyme.org**

Tool and Die Makers

(O*NET 89102)

Significant Points

- Tool and die makers learn their trade through 4 or 5 years of education and training in formal apprenticeships, postsecondary programs, or informal on-the-job training.
- Advancements in automation and increased imports of precision metal products will contribute to the projected decline in employment; nevertheless, jobseekers with the appropriate skills and background should enjoy excellent opportunities.

Nature of the Work
Tool and die makers are among the most highly skilled production workers in the economy. These workers produce tools, dies, and special guiding and holding devices that enable machines to manufacture a variety of products we use daily—from clothing and furniture to heavy equipment and parts for aircraft.

Toolmakers craft precision tools which are used to cut, shape, and form metal and other materials. They also produce jigs and fixtures (devices that hold metal while it is bored, stamped, or drilled) and gauges and other measuring devices. Diemakers construct metal forms (dies) that are used to shape metal in stamping and forging operations. They also make metal molds for diecasting and for molding plastics, ceramics, and composite materials. In addition to developing, designing and producing new tools and dies, these workers may also repair worn or damaged tools, dies, gauges, jigs, and fixtures.

To perform these functions, tool and die makers employ many types of machine tools and precision measuring instruments. They must also be familiar with the machining properties, such as hardness and heat tolerance, of a wide variety of common metals and alloys. As a result, tool and die makers usually must have a much broader knowledge of machining operations, mathematics, and blueprint reading than most other machining workers.

Working from blueprints or instructions, tool and die makers first must plan the sequence of operations necessary to manufacture the tool or die. Next, they measure and mark the pieces of metal that will be cut to form parts of the final product. At this point, tool and die makers cut, drill, or bore the part as required, checking to ensure that the final product meets specifications. Finally, these workers assemble the parts and perform finishing jobs such as filing, grinding, and polishing surfaces.

Modern technology is helping to change the ways that tool and die makers perform their jobs. For example, these workers increasingly use computer-aided design (CAD) to develop products and parts. Specifications entered into computer programs can be used to electronically develop drawings for the required tools and dies. The electronic drawings are then processed by a computer-aided manufacturing (CAM) program to calculate cutting tool paths and the sequence of operations. Once these instructions are developed, computer numerically controlled (CNC) machines usually are used to produce the die. Programs can also be electronically stored and adapted for future use, saving time and increasing worker productivity.

Working Conditions
Tool and die makers usually work in toolrooms. These areas are quieter than the production floor because there are fewer machines in use at one time. They are also generally clean and cool to accommodate the growing number of computer-operated machines. To minimize the exposure of workers to moving parts, machines have guards and shields. Tool and die makers must also follow safety rules and wear protective equipment, such as safety glasses to shield against bits of flying metal, earplugs to protect against noise, and gloves and masks to reduce exposure to hazardous lubricants and cleaners. These workers also

Tool and die makers must be mechanically inclined and able to solve problems independently.

need stamina because they often spend much of the day on their feet and may do moderately heavy lifting.

Companies employing tool and die makers have traditionally operated only one shift per day. However, as the cost of new machinery and technology has increased, many employers now have more than one shift. Overtime and weekend work are common, especially during peak production periods.

Employment

Tool and die makers held about 138,000 jobs in 1998. Most worked in industries that manufacture metalworking machinery and equipment, motor vehicles, aircraft, plastics products, telecommunications equipment, and medical instruments. Although they are found throughout the country, jobs are most plentiful in the Midwest, Northeast, and West Coast, where many of the metalworking industries are located.

Training, Other Qualifications, and Advancement

Tool and die makers learn their trade through 4 or 5 years of education and training in formal apprenticeships, postsecondary programs, or informal on-the-job training. The best way to learn all aspects of tool and die making, according to most employers, is a formal apprenticeship program that combines classroom instruction and job experience. These programs are rare, however. A growing number of tool and die makers receive most of their formal classroom training from community and technical colleges.

Tool and die maker trainees learn to operate milling machines, lathes, grinders, and other machine tools. They also learn to use handtools for fitting and assembling gauges, and other mechanical and metal-forming equipment. In addition, they study metalworking processes such as heat treating and plating. Classroom training usually consists of mechanical drawing, tool designing, tool programming, blueprint reading, and mathematics courses, including algebra, geometry, trigonometry, and basic statistics. Tool and die makers increasingly must have good computer skills to work with CAD technology and CNC machine tools.

Workers who become tool and die makers without completing formal apprenticeships generally acquire their skills through a combination of informal on-the-job training and classroom instruction at a vocational school or community college. They often begin as machine operators and gradually take on more difficult assignments. Many machinists become tool and die makers. In fact, tool and die makers are often considered highly specialized machinists. (See the statement on machinists and machine tool programmers elsewhere in the *Handbook*.)

Because tools and dies must meet strict specifications—precision to one ten-thousandth of an inch is common—the work of tool and die makers requires a high degree of patience and attention to detail. Good eyesight is essential. Persons entering this occupation should also be mechanically inclined, able to work and solve problems independently, and capable of doing work that requires concentration and physical effort.

There are several ways for skilled workers to advance. Some move into supervisory and administrative positions in their firms; some obtain their college degree and go into engineering; others become tool designers or machine tool programmers; and many start their own shops.

Job Outlook

Employment of tool and die makers is expected to decline through 2008. Nevertheless, jobseekers with the appropriate skills and background should enjoy excellent opportunities as employers across the Nation report difficulties in finding qualified workers to fill these positions. Moreover, many openings will be created each year by tool and die makers who retire. As more of these highly skilled workers retire, employers in certain parts of the country, who are already facing a shortage of workers, may face even more pronounced shortages, which will contribute to declining employment in the occupation.

Apart from a shortage of new entrants, the projected decline in employment reflects advancements in automation, including CNC machine tools and computer-aided design. CNC machine tools have made tool and die makers more productive, while CAD and CAM have allowed some functions previously performed by these workers to be carried out by a computer and CNC programmer. Because precision metal products are a primary component of manufacturing machinery, increased imports of finished goods and precision metal products, including tools and dies, may lessen the demand for tool and die makers. However, these workers are highly skilled and play a key role in the operation of many firms. As firms invest in new equipment, modify production techniques, and implement product design changes more rapidly, they will continue to rely heavily on skilled tool and die makers for retooling. This fact, coupled with a growing demand for motor vehicles, aircraft, machinery, and other products that use machined metal parts, should help to moderate the decline in employment.

Earnings

Median annual earnings of tool and die makers were $37,250 in 1998. The middle 50 percent earned between $29,910 and $45,240. The lowest 10 percent had earnings of less than $23,960, while the top 10 percent earned over $51,160. Median annual earnings in the manufacturing industries employing the largest number of tool and die makers in 1997 are shown below.

Motor vehicles and equipment	$43,400
Aircraft and parts	39,800
Metal forgings and stampings	39,600
Miscellaneous plastics products	35,700
Metalworking machinery	34,600

Related Occupations

The occupations most closely related to the work of tool and die makers are other machining occupations. These include machinist, mold maker, instrument maker, metalworking and plastics-working machine operator, and machine tool programmer.

Other occupations that require precision and skill in working with metal include blacksmith, gunsmith, locksmith, metal patternmaker, and welder.

Sources of Additional Information

For information about careers in tool and die making, contact:

☛ The National Tooling and Machining Association, 9300 Livingston Rd., Ft. Washington, MD 20744. Internet: **http://www.ntma.org**

☛ Precision Metalforming Association, Tool & Die Division, 6363 Oak Tree Blvd., Independence, OH 44131-2500. Internet: **http://www.metalforming.com**

☛ Tooling and Manufacturing Association, 1177 South Dee Rd., Park Ridge, IL 60068. Internet: **http://www.tmanet.com**

Welders, Cutters, and Welding Machine Operators

(O*NET 91702, 91705, 93914A, 93914B, and 93914C)

Significant Points

- Training for welders can range from a few weeks of school or on-the-job training for low skilled positions to several years of combined school and on-the-job training for high skilled jobs.
- Job prospects should be excellent, as employers report a shortage of qualified applicants.

Nature of the Work

Welding is the most common way of permanently joining metal parts. In this process, heat is applied to metal pieces, melting and fusing them to form a permanent bond. Because of its strength, welding is used in shipbuilding, automobile manufacturing and repair, aerospace applications, and thousands of other manufactured products. Welding is also